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(54) **OPTIMAL ORDER CHOICE: EVALUATING UNCERTAIN DISCOUNTED TRADING ALTERNATIVES**

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(52) **U.S. Cl.** **705/36**; 705/36; 705/35; 705/37

(58) **Field of Search** 705/35, 36, 37

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,819,237 A * 10/1998 Garman 705/36
6,078,904 A * 6/2000 Rebane 705/36

FOREIGN PATENT DOCUMENTS

WO WO 01/09698 A2 * 8/2001

OTHER PUBLICATIONS

Patrick Sandas, Estimating Models of Price Formation in Pure Limit Order Markets, Dec. 1998, Doctoral Dissertation, pp. 1–7.*

Tradeworx Press Releases to Sep. 30, 1999 and TREQ description.*

Figlewski, Stephen, 1997, Forecasting volatility, *Financial Markets, Institutions & Instruments*, 6(1), 1–88.

Harris, Lawrence and Joel Hasbrouck, 1996, Market vs. limit orders: The SuperDot evidence on order submission strategy, *Journal of Financial and Quantitative Analysis*, 31, 213–231.

Hausman, J., A. Lo, and C. MacKinlay, 1992, An ordered profit analysis of transaction stock prices, *Journal of Financial Economics*, 31, 319–379.

Lin, Ji–Chai and Michael S. Rozeff, 1994, Variance, return, and high–low price spreads, *The Journal of Financial Research*, 17(3), 301–319.

Merton, Robert C., *Journal of Economic Theory*, 3, 373–413.

Pratt, John W., 1964, Risk aversion in the small and in the large, *Econometrica*, 32, 83–97.

Simaana, Yusif, Daniel G. Weaver, and David K. Whitcomb, 1998. The Quotation Behavior of ENCS and Nasdaq Market Makers, Fordham University working paper.

* cited by examiner

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(57) **ABSTRACT**

The present invention provides a method for determining whether to execute an order (or list of orders) immediately, or delay execution in exchange for a possible price savings. The method's generality enables the investor to optimize order decisions given individual beliefs about expected security returns and variance, risk aversion, and portfolio investment goals. Starting from an expected utility framework, the method maximizes the expected gains associated with trading. The method encompasses the case in which the investor plans to trade the security within a specified trading window as well as the case in which trading occurs only at attractive prices. Additionally, under the assumption of constant absolute risk aversion, the method resembles a traditional mean-variance analysis commonly used in equity portfolio management. The method also generalizes to handle the case of multiple orders and enables an investor to consider an order strategy taking overall portfolio risk into account. The method also can be used in conjunction with dynamic cost control techniques.

The method of the invention is the first such method to consider the maximization of gains in an order context as a function of both returns and the probability of the order being executed. This method is also unique in that it simultaneously accounts for the opportunity costs and the adverse selection costs of using discounted, uncertain orders such as equity limit orders, POSIT® trades, equity principal order trading, etc.

31 Claims, No Drawings

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TITLE: Optimal order choice: evaluating uncertain discounted trading alternatives

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Brief Summary Text - BSTX (91):

In order to determine the successful execution of these hypothetical limit orders, we compare the limit price with the price stream reported by TAQ throughout the trade period. When the price history shows that the price crosses the limit price, we assume that the limit order fills. When the price history does not reach the limit price, we assume that the order does not fill. However, when the minimum (maximum) price exactly equals the purchase (sale)
limit price, it is less clear whether we should assume the trade fills. We address this issue by examining the 1991 TORQ database containing actual limit order execution data. We examine those 7 securities in the TORQ which overlapped our random 100 stock sample. (One could also use actual limit orders from the TORQ data base for this analysis, but a number of possible biases would exist with such a procedure. First, while the TORQ provides thousands of limit orders, many of the observations are not independent. That is, only one buy limit order per stock per day is an independent observation. Second, limit orders are often canceled or changed; any feasible analysis would choose a sample of unchanged orders, and this sample may be biased.) For these
7 securities, we examined all of the `good-until-canceled` and `day-orders` placed from November 1991 through January 1992. The analysis is presented in
Example 1, below. The results demonstrate that, on average, 70% of the limit orders placed were at least partially filled when the trade record showed a price exactly equal to, but not beyond, the limit order price within the trade period. This is consistent with Lo, MacKinlay, and Zhang (1997), who calculated similar statistics using an industry data set. Since we will use the simplification that order size is small (and therefore s is approximately equal to 1), we will also assume that a limit order fills if the price stream crosses the limit price, that it fills 70% of the time if the price stream